Estimating Mental Illness in an Ongoing National Survey

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1. Introduction

There has long been a need for estimates of the prevalence of mental disorders in the U.S. population. Periodic studies such as the Epidemiologic Catchment Area (ECA) study, the National Comorbidity Study (NCS), and the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) have provided important findings on the prevalence, predictors, and correlates of mental disorders, but none of these studies were designed to track trends on an annual basis or to provide state estimates.

The demand for more frequent and detailed data on mental illness increased with the passage of the 1992 ADAMHA Reorganization Act. This legislation created the Substance Abuse and Mental Health Services Administration (SAMHSA) and required the agency to develop a definition and methodology for estimating serious mental illness (SMI) among adults, by State. States were required to utilize these measures in developing their plans for use of block grant funds distributed by SAMHSA. SAMHSA convened a technical advisory group (TAG) that developed a definition of SMI, published in the Federal Register in 1993 (SAMHSA, 1993):

> 'Persons aged 18 and over, who currently or at any time during the past year, have had diagnosable mental, behavioral, or emotional disorder of sufficient duration to meet diagnostic criteria specified within DSM-III-R that has resulted in functional impairment.' … 'Functional impairment is defined as difficulties that substantially interfere with or limit role functioning in one or more major life activities including basic daily living skills; instrumental living skills; and functioning in social, family, and vocational/educational contexts.'

In 1998 SAMHSA published state estimates of SMI based on this definition, using the limited data that were available at the time (NCS and ECA) and a regression model that projected national data to states according to demographic characteristics (Kessler et al, 1998). However, concerns about the validity of these estimates led SAMHSA to explore other approaches for obtaining annual estimates of SMI by state.

In December 2006, SAMHSA convened a TAG meeting to solicit recommendations for mental health surveillance data collection and analysis strategies. The TAG recommended that SAMHSA's National Survey on Drug Use and Health (NSDUH) be modified to produce estimates of SMI among adults. Recognizing the limitations on how long the NSDUH interview can be, the TAG suggested that the K6 psychological distress scale, already included in the NSDUH, be supplemented with questions on functional impairment, as both of these scales in combination were expected to be strong predictors of SMI. The TAG suggested that the data from these short scales be used to estimate SMI, using a statistical model based on clinical psychiatric interviews conducted on a subsample of NSDUH respondents. The K6 had already been demonstrated to be a good predictor of SMI in prior studies (Kessler et al, 2003). Adding impairment indicators, as specified by the TAG, would improve statistical prediction and also add face validity, and consequently public acceptance of the estimates, since impairment is a component of the SMI definition. After the TAG meeting, SAMHSA began the development and testing of a program to implement these enhancements, collectively referred to as the Mental Health Surveillance Study (MHSS) (Colpe et al, 2010). Based on the Federal Register definition, SAMHSA established an operational definition of SMI among adults: at least one DSM-IV disorder, other than developmental or substance-use disorder, in the past 12 months that resulted in serious

impairment. Serious impairment was determined to be equivalent to a DSM-IV Axis V Global Assessment of Functioning (GAF) score of less than or equal to 50.

The next section provides an overview of the NSDUH design. Subsequent sections describe the development, implementation and initial results of the MHSS. A final section discusses future plans for evaluating, improving, and utilizing the MHSS.

2. Description of the NSDUH

The NSDUH is the federal government's primary source of information on the nature and extent of substance use and abuse in the United States. Conducted since 1971, the survey collects data by administering questionnaires to a representative sample of about 67,500 persons in the United States at their place of residence. NSDUH data are used extensively by policymakers and researchers to describe the prevalence and correlates of substance use and mental illness, to identify and monitor trends, and to analyze differences in substance use patterns by population subgroups.

The respondent universe is the civilian, noninstitutionalized population aged 12 years old or older residing within the United States. Persons excluded from the universe include active-duty military personnel, persons with no fixed household address (e.g., homeless and/or transient persons not in shelters), and residents of institutional group quarters, such as prisons and long-term hospitals. The eight largest states have samples of about 3,600 respondents. For the remaining 42 States and the District of Columbia, samples of about 900 persons are selected. Young people are oversampled, with one-third of the sample in each state allocated to the following three age groups: 12-17, 18-25, and 26 and older. That is, although the overall sample of adults consists of 45,000 respondents, half of the adult sample is between the ages of 18 and 25. At each sampled address, a 5-minute screening procedure using a handheld computer lists all household members and their basic demographic data. To obtain the target sample sizes, a preprogrammed selection algorithm selects zero to two sample person(s), depending on the composition of the household.

The data are collected through face-to-face computer-assisted interviewing (CAI), including audio computer-assisted self-interviewing (ACASI), on a laptop computer. The interviews average about an hour. Each respondent who completes a full interview is given a $30 cash payment. The questionnaire contains demographic items (which are interviewer-administered) and self-administered questions pertaining to the use of tobacco, alcohol, and illicit drugs, as well as injection drug use, perceived risks of substance use, substance dependence and abuse, arrests, treatment for substance use problems, pregnancy, health conditions, health care utilization, and mental health (SAMHSA 2010).

3. Design of the Mental Health Surveillance Study (MHSS)

The MHSS is a multi-component study consisting of short scales included in a large sample of the population, detailed diagnostic data collected from a small subsample, and statistical analysis of the combined data set to produce estimates of mental illness. That is, the MHSS collects data in a separate clinical follow-up study on a subsample of NSDUH respondents. Prediction models of SMI and AMI were developed from this subsample of respondents, using the data reported by these respondents from short scales on psychological distress and impairment that are within the NSDUH, combined with their clinical interview data. These models are used to produce predicted probabilities of SMI for each of the adult respondents in the main NSDUH which are then used to produce national estimates of SMI.

3.1 Main NSDUH Interview Mental Health Scales

In consultation with the TAG, two candidate impairment scales were selected and modified for use in the 2008 NSDUH. They are the World Health Organization Disability Assessment Scale (WHODAS; Rehm et al., 1999) and the Sheehan Disability Scale (SDS; Leon et al, 1997). Half of the NSDUH adult sample was randomly assigned the WHODAS and the other half the SDS.

The WHODAS consists of a series of 16 questions that is used for assessing disturbances in social adjustment and behavior. Because of the length of the WHODAS, an IRT analysis was done to see if a reduced set of items would be sufficient for measuring impairment. This resulted in an abridged set of eight WHODAS items that were added to

the NSDUH (Novak et.al., 2010). Respondents were asked how much difficulty they had doing each of eight activities "during the one month in the past 12 months when your emotions, nerves, or mental health interfered most with your daily activities." The eight items were assessed on a 0 to 3 scale with categories of "no difficulty" (0); "mild difficulty" (1); "moderate difficulty" (2); and "severe difficulty" (3).

The SDS consists of a series of questions used to measure impairment in a person's daily functioning in four role domains. Respondents were asked how much their "emotions, nerves or mental health" interfered with each role domain "… during the month in the past 12 months when you were at your worst emotionally." The SDS role domains are assessed on a 0-10 visual analog scale with impairment categories of "none" (0), "mild" (1-3). "moderate" (4-6), "severe" (7-9) and "very severe" (10).

The K6 scale, included in the NSDUH since 2002, measures past year nonspecific psychological distress. It consists of six questions asking frequency of symptoms during the month in the past year when the respondent was at their worst emotionally. Response options are "none of the time" (0), "a little of the time" (1), "some of the time" (2), "most of the time" (3), and "all of the time" (4). The sum of the values for the six questions is the K6 score (range 0 to 24).

3.2 Clinical Follow-up Interview

3.2.1 Content of the Clinical Interview

The clinical diagnostic interview used in the MHSS is the Structured Clinical Interview for DSM-IV-TR Axis I Disorders Non-Patient Edition (SCID-I/NP). The SCID-I/NP (First et al., 2002) is a semi-structured diagnostic interview that has been widely used in clinical components of studies such as the NCS-R (Kessler et.al., 2004), the National Survey of American Life (Jackson et al, 2004), and the NSDUH substance-use disorders reappraisal study (Jordan, et al, 2008). The interview was modified to assess past 12-month mental health disorders and functioning via telephone.

Diagnostic modules contained in the MHSS version of the SCID include mood, psychotic, anxiety, eating, impulse control, substance use and adjustment disorders. Also included in the MHSS follow-up interview is the DSM-IV Axis V GAF Scale, a clinical interviewer (CI) rating of the respondent's period of worst psychological, social and occupational functioning during the past year. Functioning is rated on a scale from 1-100.

3.2.2 Field Interviewer (FI) and Clinical Interviewer (CI) Training

For the clinical follow-up study, all NSDUH FIs were required to review a handbook, complete an electronic training course, and attend a 1-hour classroom training session (Colpe et al, 2010). Clinical interviews were conducted by masters- and doctoral-level mental health professionals who had been carefully and extensively trained to administer the SCID over the telephone. Training was led by four clinical supervisors (CSs) – experts in the DSM and the SCID – and was overseen by the lead author of the SCID. The study protocol included comprehensive instructions for identifying and managing distressed respondents as well as ongoing supervision and inter-rater training exercises for the clinical interviewers.

3.2.3 Protocol for the MHSS Subsample Recruitment

At the end of the main NSDUH interview, a subsample of adult respondents was asked if they would be willing to participate in an additional study that would gather more information about their recent mental health history. The request was scripted as part of the CAPI interview, and field interviewers (FIs) did not know in advance which respondents would be selected. Selected respondents were presented with a separate study description as part of the informed consent procedures. Those agreeing to participate were given a $30 cash incentive in addition to the $30 they received for completing the main NSDUH. FIs collected contact information (first name, telephone number(s) and best days and times to call). Within 2 to 4 weeks of the NSDUH main interview clinical interviewers called respondents and conducted the SCID interview. CIs completed the SCID on paper and audio-recorded the interview (with permission).

3.2.4 Sample Design and Response Rates for the 2008 and 2009 MHSS

The two primary objectives for the first year of the MHSS were to (1) determine which of the two impairment scales, used in combination with the K6 scale, provided the more accurate prediction of SMI and would therefore be administered to the entire sample of adults in the 2009 and later surveys, and (2) develop prediction models that will accurately classify NSDUH respondents as meeting or not meeting criteria for SMI. A subsample of approximately 1,500 adult NSDUH participants was selected for the follow-up clinical interview (750 from each of the main study half-samples). The SCID subsample was stratified, based on respondents' K6 scores, to optimize the sample allocation for prediction modeling. Strata were constructed according to seven K6 scoring bands. Sampling rates were substantially lower for K6 scores 0 to 7 under the assumption that clinical positives would be rare in that scoring range. The 2009 sample size was approximately 500, employing the WHODAS scale for the entire sample, as it was determined to predict SMI better than SDS scale (see Section 4). Of the 3,062 NSDUH respondents selected for the follow up interview during 2008 and 2009, clinical interviews were completed for 2,207. The most common reasons for noncompletion were refusal and inability to contact respondents who had initially agreed to participate (Table 1).

Table 1. Clinical Interview Sample Disposition, combined 2008-2009

	Selected	Completed Interview	Initial Refusal, no Completed Interview	Agreed to Participate, but Not able to Contact	Other Nonresponse
Number	3,062	2,027	420	477	138
Percent					
Unweighted	100.0	66.2	13.7	15.6	4.5
Weighted	100.0	59.5	24.3	12.5	3.7

4. Model Development and Estimation

Using the SCID subsample, a series of weighted logistic regression prediction models were developed in which the K6 and either the WHODAS or SDS (collected within the main study) were used as explanatory variables of SMI status (collected from the SCID interview) (Aldworth et al, 2010). The response variable, *Y*, was defined such that *Y* = 1 when an SMI diagnosis is positive; otherwise, *Y* = 0. If **X** is a vector of explanatory variables, then the response probability $\pi = \Pr(Y = 1|\mathbf{X})$ can be estimated using separate weighted logistic regression models for each of the WHODAS and SDS half samples. For each model, a cut point probability π_0 was determined, so that if $\hat{\pi} \geq \pi_0$ for a particular respondent, then he or she was *predicted* to be SMI positive; otherwise, he or she was predicted to be SMI negative. Receiver Operating Characteristic (ROC) analyses were used to determine the cut point that resulted in (approximately) equal weighted numbers of false-positives and false-negatives, to provide nearly unbiased estimates. Models were evaluated based on three criteria: (1) model robustness (e.g., preference given to parsimonious models that could be implemented in other surveys collecting similar covariates); (2) minimization of misclassification errors in SMI prediction (i.e., exhibiting reasonable ROC statistics) and (3) reasonable SMI estimates based on the full 12-month dataset (i.e., balanced across several demographic subgroups and across the WHODAS and the SDS half samples).

ROC analysis of various models demonstrated the advantage of including an impairment indicator in the model, rather than using only K6 as a predictor of SMI, as had been suggested in earlier NSDUH studies (Kessler et al 2003). For example, in the 2008 SCID sample the false positive and false negative rates were approximately 20 percent lower with the final K6 plus WHODAS prediction model than with a K6-only model. Also, model fit statistics and sensitivity analyses indicated that in combination with the K6, the WHODAS was a better predictor of

SMI than the SDS. Consequently, this impairment scale was chosen for administration in the 2009 and subsequent surveys. The final prediction model selected for estimating SMI incorporates both the K6 and WHODAS and is as follows, with a cutpoint, π_0, of 0.26972:

$$\text{logit}(\hat{\pi}) \equiv \log[\hat{\pi}/(1-\hat{\pi})] = -4.7500 + 0.2098X_k + 0.3839X_w \quad (1)$$

where $\hat{\pi}$ refers to an estimate of the SMI probability π for the model,

X_k refers to the recoded past year K6 score, where scores less than 8 were recoded as 0, and scores of 8 to 24 were recoded as 1 to 17,

X_w refers to the sum of recoded WHODAS item scores, where item scores of 0 or 1 were recoded as 0, and item scores of 2 or 3 were recoded as 1. Thus, X_w ranges from 0 to 8.

Although SAMHSA's primary objective was to derive model-based estimates of SMI, an estimate of "any mental illness" (AMI) also was of interest. AMI, defined similarly to SMI with respect to the presence of a diagnosable mental disorder, does not require functional impairment from the disorder. After assessing a variety of models, the original SMI model was chosen to estimate AMI, using a lower cutpoint of 0.024. Cutpoints were determined for three levels of mental illness, using the GAF scores obtained in clinical interviews to define each level. Besides SMI, moderate mental illness (MMI) was defined as having a disorder along with a GAF score from 51 to 59, and low or mild mental illness (LMI) was defined as having a disorder and a GAF score greater than 59.

5. Results and Comparison with Other Data Sources

National model-based estimates for 2008 were 4.4 percent for SMI and 19.5 percent for AMI (SAMHSA, 2010). In 2009, the estimates were 4.8 and 19.9 percent, respectively. For both SMI and AMI, rates were higher for females and higher for young adults aged 18 to 25 than for older adults (Table 2). These prevalence rates, as well as patterns across subgroups and correlations with key variables (e.g., treatment), were compared with corresponding estimates from other studies such as the National Comorbidity Study and found to be similar (Hedden, Gfroerer, Barker, et al., 2012).

Table 2. Estimates of Rates of Mental Illness among Adults aged 18 or older, based on the National Survey on Drug Use and Health

Demographic Group	Percent With Any Mental Illness (SE)		Percent With Serious Mental Illness (SE)	
	2008	2009	2008	2009
Total	19.5 (0.45)	19.9 (0.30)	4.4 (0.14)	4.8 (0.15)
Male	15.1 (0.57)	15.6 (0.39)	3.0 (0.17)	3.2 (0.18)
Female	23.5 (0.65)	23.8 (0.44)	5.6 (0.22)	6.4 (0.24)
Age 18 to 25	30.9 (0.56)	30.0 (0.41)	7.4 (0.22)	7.3 (0.22)
Age 26 to 49	20.9 (0.57)	22.3 (0.44)	5.2 (0.22)	5.9 (0.24)
Age 50 and Older	13.8 (0.84)	13.7 (0.52)	2.3 (0.23)	2.8 (0.24)

6. Key Issues and Future Directions

6.1 Updating the Models and Measuring Changes Across Time

The MHSS was initiated in 2008 with about 1500 clinical interviews, and has been continued with 500 clinical interviews completed in 2009 and 2010, and 1,500 interviews in 2011 and 2012. The expanded samples in 2011 and 2012 were supported by funding from the National Institute of Mental Health (NIMH). There are several options under consideration for a long-term strategy for the estimation of SMI and other mental illness levels. One approach would be to identify a new "best" prediction model each year using the additional clinical interview data. However, given the small size of the SCID subsample each year, the updated model would likely introduce substantial variability that would make trend analysis unreliable. Data from the 2009 SCID sample produced parameter estimates similar to those from 2008, providing evidence that the 2008 models are reasonable. Therefore, the 2008 WHODAS model, parameter estimates, and cut points were used by SAMHSA to produce 2009 and 2010 national estimates of SMI and AMI prevalence. SAMHSA plans to continue to apply the 2008 model for 2011 estimation, but to re-evaluate after more SCID data are accumulated in 2011 and 2012. Combining 2008 through 2012 data, there will be more than 4,500 completed SCID interviews available for the evaluation and possible enhancement to the 2008 model which was developed based on approximately 750 cases. Predictors other than the K6 and WHODAS variables currently used that could be tested in models include alternative recodes of K6 and WHODAS, individual items from K6 and WHODAS, and indicators of suicide thoughts and depression symptoms. SAMHSA is also exploring estimation methods that correct for bias within population subgroups. This bias may occur because the chosen cut-point for the final model equalized the weighted numbers of false-positive and false-negative counts of SMI for the overall sample, but the false-positive and false-negative counts may not necessarily be equally distributed within population subgroups.

6.2 Estimation of the Variance of SMI and AMI

Currently the variance that has been estimated for SMI and AMI assumes that the prediction model is correct and the estimated parameters from the prediction model are the ‘true’ parameters. The calculation of the standard errors (e.g., Table 2) does not take into account the variability incurred by using a small sample-based model to calculate predicted values which are then used to produce estimates of SMI and AMI. A study is currently underway to investigate methods for estimating a more complete set of the variance components associated with SMI and AMI estimation.

6.3 Disorder Specific Estimates using Data from the SCID

Although the primary goals of the MHSS study were to produce model-based estimates of SMI and AMI, the nationally representative SCID data could potentially be used to produce direct estimates of specific mental disorders. Direct, disorder-specific estimates have been generated for each year of data collection, for 2008, 2009 and 2010, and by combining 2008-2010 data. Preliminary results indicate that disorder specific estimates produced separately for each year of collection were unstable and affected by extreme weights. Further investigations are continuing.

6.4 Determining an Optimal Sample Design for Model-Based and Direct Estimates

Since one of the initial goals of the MHSS was to develop models for estimating SMI, the sample design oversampled cases with higher K6 scores and had very low sampling rates for cases with K6 scores below 4. In addition, the main NSDUH sampling rates varied by age and state. The resulting extreme variation in sampling weights created difficulties in the analysis, particularly due to the small number of cases with very large weights (primarily older adults with low K6 scores) that were diagnosed with SMI in the SCID. In addition, the shift in focus to include the estimation of AMI created a need for a more balanced design, so SAMHSA made adjustments to the sampling rates to attempt to address this, increasing the sampling rates for low K6 scores (beginning July 2009) and reducing the sampling rate for 18-25 year olds (beginning January 2010). However, a clear approach to make decisions about the design of the SCID subsample has yet to be determined.

6.5 Nonresponse Bias

Since the recruitment for the clinical follow-up occurs after the main NSDUH interview is completed, data from the entire NSDUH interview are available for both the respondents and nonrespondents to the MHSS. This allows for the evaluation of nonresponse bias between the NSDUH interview and the clinical interview. Differences between clinical interview respondents and nonrespondents on demographic variables as well as substance use, health and mental health status can be investigated. Preliminary results show that adults sampled who initially refused to participate had much lower rates of mental health problems than NSDUH respondents, while those not completing the SCID interview after agreeing to participate (and collecting the $30 incentive) had rates similar to NSDUH respondents (Table 3). Analyses will evaluate whether there is a relationship between the main study key outcome variables and propensity to respond, whether persons with low response propensities are similar to nonrespondents on key outcome measures, and whether there is a relationship between response propensity and the clinical mental health measures collected through the SCID. Results from these analyses will be used to assess the non-response bias and to better inform the adjustment for non-response via weighting.

Table 3. Characteristics of Completed Clinical Interviews and Nonrespondents in the Clinical Follow-up, 2008-2009: Weighted Percentages with Sociodemographic, Substance Use or Mental Health Characteristic

Domain	Completed Interview	Initial and Final Refusal	Agreed to Participate, but Not able to Contact	All Nonrespondents
Sociodemographic Group				
Male	47.4	41.9	60.7	47.9
Age 18-25	16.8	9.2*	19.8	12.6
Hispanic	7.7	14.3	29.6*	19.6*
<$20k Family Income	12.0	9.7	29.7*	17.6
College Graduate	30.4	36.2	9.6*	25.9
Past Year Characteristic				
Cigarette Use	32.0	26.3	51.1*	33.9
Marijuana Use	17.1	5.5*	18.2	10.3
Suicide Thoughts	3.7	1.3*	4.9	3.0
Mental Health Treatment	15.0	9.9	15.5	12.1

* Difference between estimate and "completed interview" estimate is statistically significant at .05 level.

7. Conclusion

The Mental Health Surveillance Study has proven to be a useful addition to the National Survey on Drug Use and Health. It has provided a new source of key indicators of the mental health status of the U.S. population, with the ability to track these indicators over time and across detailed subpopulations, including state and substate areas. A number of methodological concerns and questions emerged as the MHSS was implanted and as it continues. SAMHSA is continuing to address these issues, and it is expected that results from this methods research will lead to improvements in the NSDUH MHSS, and also findings that may have applications for other surveys.

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